Remarks

Claims 2, 4 and 19 - 21are withdrawn. The dependency of claims 3, 5, 6, 7, 8, and 9 is changed to depend from claim 1. Claims 1, 3, and 5 – 18 are pending. Reconsideration of those claims is requested.

Claim 1 is based on the former claim 1 whereby it has been clarified that the light beams of the selected wavelengths are emitted sequentially. This feature is an aspect of the function of the confocal scanning microscope of the invention and is supported by the description on page 9, para. [00040]. Further, the drive parameters of the AOD that are dynamically controlled by the electronic control and imaging system in accordance with the changes of the wavelength are specified on the basis of the description page 7, para. [00030].

In claim 3 the purpose of the pivoting of the mirror and AOD by the electronic control and imaging system has been clarified on the basis of the description page 10, para. [00042]. The dependency of claim 3 has been changed to claim 1

The amendments of the claims 1 and 3 have been made to clarify the differences between the present invention and the prior art documents cited against the respective claims.

In a confocal imaging system based on the use of an acousto-optical deflector (AOD) for the fast scanning axis there are a number of issues that need to be addressed.

The performance of an AOD scanning system depends on a number of parameters including the scanning speed, the absolute wavelength, the range of wavelengths used and the required field of view. Several methods are available to compensate for changes in these parameters.

If more than one wavelength simultaneously (or sequentially) scans the image (sample) with a common AOD drive frequency range then each wavelength scans different positions on the sample due to the wavelength dispersion characteristics of the AOD. The result is a requirement for substantial processing of the data after detection to discard the image data from the 'over-scanned' regions. In confocal imaging this 'over-scanning' of the sample is unacceptable. Illumination of these 'over-scanned' regions by some of the wavelengths may make them unusable for further imaging purposes since these regions may suffer from unwanted effects such as photo-bleaching of the

fluorophores and photo-toxic effects on the sample material (especially with living cells, a common sample type for confocal imaging).

The invention featured in the pending claims now aims at solutions to compensate the negative influences on image quality caused by the so-called lensing effect of the AOD when rapid changes of the input beam wavelengths or scanning rates are made and to maintain optimum resolution and image quality.

The problem of the lensing effect induced by the AOD is not addressed in any of the cited references. Accordingly, the skilled person seeking for information on the solution to the problems associated therewith will not be given relevant information rendering obvious the solutions as defined in the laims 1 and 3.

The following comments relate to the prior art of record in this application.

Document US-B-6449039 (D1 in corresponding EP application)

This document relates to a two-photon or multi-photon confocal laser scanning microscope based on AOD scanning technology using short pulsed laser sources. In this type of microscope the rotation of the AOD (and mirror/prism) is required to achieve an efficient transfer of the illumination through the AOD at the near IR wavelengths required for this type of confocal microscopy. With the short pulses used in this type of microscope no fast switching or change of input wavelengths is possible at all and the lensing effect is accordingly not addressed in this reference.

Furthermore, in the microscope of the invention the rotation of the AOD (and mirror) is required to achieve greater overlap of the deflection ranges of the shortest and longest wavelengths used, this is to maintain the largest field of view scanned by the desired range of wavelengths and not for greatest efficiency (see Fig 4 of the application). This difference is now clearly recited in the new claim 3.

Document US-B-6510001 (D2 in corresponding EP application)

The applicant's understanding of the operation of an AOD does not match the description used in this document. For an AOD, any wavelength of laser light will be deflected in proportion to the acoustic frequency applied across it, hence with multiple wavelengths and multiple frequencies applied simultaneously, there will be multiple deflected beams at all wavelengths. In the case of an AOTF, all beams appear at

deflection order zero, unless an acoustic frequency is applied that corresponds to deflecting a particular wavelength to the first order deflection angle. Thus in an AOTF, multiple frequencies and multiple wavelengths permit only emitted beams at zero order and first order deflection, a required condition for operation as a multiple wavelength beam-splitter (see D2, claim 1).

This document does not reference the use of an AOD as a scanning device, but only as a selection device, and the AOTF is generally solely a selection device.

Document EP-A-0 284136 (D3 in corresponding EP application)

This document describes the basic structure of the AOD based confocal microscope and is discussed in the description introduction of the patent application. It suffers from the problems mentioned above and does not contain information towards the solution provided by the present application.

Document US-A-4835601 (D4 in Corresponding EP application)

This document describes a system in which 3 different laser wavelengths are simultaneously scanned by an AOD over a sample area. The characteristics of the AOD make each laser wavelength scan over a different part of the sample. Each wavelength scan is displaced from the others in the scan direction of the AOD due to the deflection angle of the AOD being proportional to the wavelength of the laser line. The length of the scan line is also longer for the longer wavelength laser lines for the same reason. This requires processing of the detected signal to extract those parts of the scanned regions which are scanned by all 3 wavelengths, and adjustment of the digitisation of the 3 signals to permit them to be overlaid on each other. The over-scanning of the sample frequently causes some areas to be over-exposed to the illumination resulting in additional photo-bleaching and photo-toxicity artefacts.

Since the time taken for the acoustic signal to cross the AOD aperture is a constant, the frequency difference across the aperture is also constant for each of the wavelengths. This results in a different 'lensing' effect at each wavelength (since the angle of deflection is proportional to wavelength) which causes a difference in astigmatism for each wavelength (a condition not identified in D4). The changes in astigmatism (if not compensated) cause the scanning spot in the confocal microscope to

diverge from a diffraction limited spot in the sample focal plane, which is a necessary condition for optimum resolution in a confocal microscope.

Different from the structure of '601 patent and in accordance with the clarification made in the new claim 1 the microscope of the invention scans each wavelength sequentially through the AOD and adjusts the start and end drive frequencies for each wavelength such that the area scanned at each wavelength is the same. The advantage of this approach is the elimination of 'over-scanned' regions at both edges which is an essential condition for recording from adjacent fields of view.

This adjustment of the start and end scanning frequencies also ensures that the 'lensing' effect is constant at all wavelengths, given that in a single experiment a constant angular scanning rate is used for all wavelengths. D4 does not suggest this measure and relies on a basically different approach, i.e. simultaneous scanning vers. sequential scanning.

US 6,738,190 corresponding to 2002/0027709 cited at page 4 of office action

The reference US 6,738,190 describes a confocal scanning microscope that addresses the problem that previous microscopes of this type do not allow a reliable selction and definition of details of interest in a specimen but rather illuminate the specimens over the entire scan field. The problem addressed by the present invention, i.e. the elimination of 'over-scanned' regions at both edges which is an essential condition for recording from adjacent fields of view, or in other words, the aim to make the 'lensing' effect of the AOD constant at all wavelengths in cases where several wavelengths are used for illumination of the specimen is not addressed in the '190 patent. In fact, the '190 patent uses an AOD not as a scanning device, but only as a selection device as an alternative to an AOTF or an EOM (see page 3, [0032] of published application).

Further, the '190 patent uses a simultaneous illumination with light of several wavelengths as in the prior art and not a sequential illumination (see page 1, [0005] of published application). Therefore, the reference generally fails to provide information for solving the problem of the invention and does not provide

any other hints or information that could suggest the measures of the invention with respect to this particular problem, i.e. the adjustment of the start and end scanning frequencies for each wavelength and the dynamic control of the rate of frequency change such that the area scanned at each wavelength is the same.

In summary, the present invention as defined in the new claim 1 is neither shown nor suggested from the prior art references in this application and therefore claim 1 is allowable. Each of the other claims depend from allowable claim 1 and are also allowable.

The Commissioner is hereby authorized to charge any required fee under 37 C.F.R. § 1.17 in connection with this communication to our Deposit Account No. 23-0630.

Respectfully submitted,

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Encls three sheets drawings, 2 replacement and
1 new.

In the Drawings

Please substitute replacement sheets 1 and 2 (designated as such) for sheets 1 and 2 as filed and add new figure 5 on the accompanying new sheet.